DOCUMENT RESUME

ED 069 433 24 PS 006 187

AUTHOR	Thomas, Susan B.
TITLE	Nutrition and Learning in Preschool Children.
INSTITUTION	ERIC Clearinghouse on Early Childhood Education, Urbana, Ill.
SPONS AGENCY	Office of Child Development (DHEW), Washington, D.C.; Office of Education (DHEW), Washington, D.C.
PUB DATE	Oct 72
NOTE	25p.
AVAILABLE FROM	College of Education Curriculum Laboratory, University of Illinois, 1210 West Springfield Avenue, Urbana, Ill. 61801 ($0.45, Catalog No. 1300-32)
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	Behavior Patterns; Disadvantaged Environment; Human Development; *Low Ability Students; Mental Retardation; *Nutrition; Physical Characteristics; Preschool Children
IDENTIFIERS	*Malnutrition

ABSTRACT

This paper describes the behavior of nutritionally deprived children, and findings indicate retarded physical and mental growth. Based on the extensive bibliography entitled, "Malnutrition, Cognitive Development and Learning," which contains 187 citations with abstracts, a concern is whether malnutrition effects are reversible or permanent. Since the child's full range of intelligence potential might be affected, he may grow into an adult who functions marginally, marry and raise a family in the same tradition. Types of malnutrition are discussed, and recommendations for nutrition education day centers for the disadvantaged are stressed. (RG)

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ED 069433

NUTRITION AND LEARNING IN PRESCHOOL CHILDREN

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PS 006187

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October, 1972

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FOREWORD

Nutrition and Learning in Preschool Children summarizes research findings that clearly indicate that lack of adequate nutrition, especially during the early years of life, contributes to retarded physical and mental growth. The paper also describes the behavior of children who have been nutritionally deprived. Particular types of malnutrition and the social, economic, and environmental variables which are contributing factors to learning problems are discussed.

The paper is based on an extensive bibliography entitled Malnutrition, Cognitive Development and Learning which contains 187 citations with abstracts, and a brief introductory paper. The bibliography is available from the University of Illinois Curriculum Laboratory, 1210 W. Springfield Avenue, Urbana, Illinois for $2.10, catalog no. 1300-29.

This paper was produced pursuant to a contract with the Office of Child Development, partially supported by a contract with the Office of Education, U.S. Department of Health, Education and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment. Points of view or opinions stated do not, therefore, necessarily represent official Government position or policy.

NUTRITION AND LEARNING IN PRESCHOOL CHILDREN

In a typical preschool class some children are alert, curious and eager to learn while others appear apathetic and listless. Children may have short or long spans of attention. In part, these variations may be attributable to differences in the children's nutrition.

Adequate nutrition is basic to optimal physical growth and development. Recent research has indicated that nutrition also influences mental development. Much of the research on the effects of malnutrition has been done with animals in experimental-laboratory type situations. Other research studies have involved children from countries in Africa, Asia, Central and Latin America. Very few malnutrition studies have been done in the United States, although the lack of research in this area does not imply that there is no problem. One impetus for research in this country has been the Head Start program, with its concomitant emphasis on sound nutrition as a basis for efficient and effective learning. Although malnutrition, especially moderate malnutrition, may not affect a child's innate level of intelligence, it may well affect his ability to use his full range of intellectual potential.

Malnutrition: What Is It?

Read (1969) defines malnutrition as a state in which an individual lacks one or more nutrients to such an extent that specific symptoms and conditions appear: anemia, goiter, rickets, vitamin deficiencies,

or retardation in physical development. In school, undernourished or hungry children frequently exhibit behavioral alterations, including apathy, lethargy, inability to pay attention and perhaps overconcern about food to such a degree that responses to classroom stimuli do not occur. A child in such a condition no longer meets the expectations of his family or teachers. He begins to live in a world of his own and may seek recognition or try to gain attention in ways that disrupt learning experiences. Parents and teachers may react to his social behavior and withdraw some of the stimulation necessary for adequate mental development.

Sulzer suggests that children with poor nutrition also have problems involving concentration, alertness, and learning. Children with low energy levels, often brought about by poor nutrition, respond to learning situations with apathy, or high excitability, neither of which is conducive to learning.

Bakan (1971) suggests that malnutrition interacts with other factors such as poverty and illness in the child's environment. These combined factors often perpetuate the cycle of illness, educational failure, and poverty. Compensatory programs such as Head Start and Follow-Through need to consider many interacting factors, rather than nutrition alone. One research finding which provides evidence of the need for adequate nutrition as well as attention to other environmental factors is the demonstration of delayed neurcintegrative development in children who have grown poorly because of malnutrition and other interacting factors. Inadequacies of intersensory development can

contribute to a child's failure to establish an ordinary normal background of experiences in his preschool years. That is, a child must be able to coordinate visual and motor skills, for example, to perform certain tasks. Poor nutrition can interfere with his development when he is too weak or tired to perform these tasks and thus might not be able to benefit fully from occurrences in his environment. Early experiences (e.g., Caldwell 1969; Hunt, 1961) are thought to facilitate intellectual development.

Birch (1968) points out that a child's nutritional inadequacy affects both his neurological maturation and his learning competency. These children suffer from lost learning time due to apathy and sluggishness, nutritional deficit during critical learning periods in the preschool years, and adverse motivation and personality changes. In intervening to provide the best learning conditions for a child, educators should recognize the importance of a child's health to his learning effectively.

Cravioto, DeLicardie, and Birch (1966) suggest that malnutrition can act in two ways: directly by interference with the central nervous system, and indirectly through interaction with social and environmental factors, including loss of learning time due to apathy and sluggishness. Personality and motivational changes may also occur as a result of child-adult interaction. Often an adult will reject an apathetic or sluggish child because of his behavior, thus compounding the biological problem of malnutrition with the social and psychological factors of rejection and lessened social interaction.

Research indicates that severe malnutrition with hospitalization has a long term persistent effect on measured intelligence, and on the learning of such basic academic skills as reading and writing (Cravioto and DeLicardie, 1970). Children who suffer from severe malnutrition early in life are handicapped educationally as well as socially. Because of the increased risk of becoming a poor reader, a poor writer, and subsequently a failure in school, the child functions at a sub-optimal level. Children who survive bouts of severe malnutrition are therefore more likely to be victims of their poor socioeconomic environment, being less than normally effective in their social adaptations. In addition, children who function marginally grow into adults who function marginally. They marry and raise families in the same tradition, thus perpetuating the cycle of poverty, malnutrition, retarded learning, and intellectual development.

Although severe malnutrition in the United States is rare, moderate malnutrition (cases not severe enough to be hospitalized) is suggested as a contributing factor to the higher morbidity and mortality rates found among low income groups (Birch, 1968). Although severe malnutrition has been found to be a causative factor in retarded intellectual development, the exact outcomes of moderate malnutrition have yet to be determined. It has been suggested that psychological, social, and cultural factors act synergistically with malnutrition to produce retarded intellectual development as well as learning disabilities. Just what effect each factor has must be determined. However, it is

known that malnutrition does play a role.

Types of Malnutrition

Research on malnutrition will often deal with a specific kind of malnourishment. Two kinds commonly studied include marasmus (or nutritional marasmus), and kwashiorkor. The term "marasmus" applies to young infants who have experienced protein-calorie malnutrition with general body wasting. It entails the severe inadequacy of all nutrients, usually from the earliest months of life, and produces infants whose physical development is grossly impaired. It is a long term condition, beginning early, and is thought to be irreversible. The term "kwashiorkor" indicates an affliction among older infants and young children who have been maintained on low protein, but modest calorie intake diets, with accompanying edema and other problems. It is basically the insufficiency of protein, and typically occurs toward the end of the first year, or during the second year of life. It often occurs after the birth of a younger sibling, when the sibling is being nursed rather than the older child.

Marasmus appears to be a more severe form of malnutrition, since it occurs in the very young child whose brain is developing at a rapid rate. Research has indicated that kwashiorkor is not necessarily associated with permanent intellectual damage, at least if the child was older than twelve months when the condition began (Pollitt, 1970).

Contributing Factors

How do the outcomes of malnutrition vary as a function of age of

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onset, severity, duration, and type of malnutrition? This is one of the questions being studied by researchers. Age of onset of malnutrition is an important factor, since by the time a child is one year old, the brain is about 70% of the size of that of an adult; by the age of four, brain growth is almost complete. Results of animal experiments lend support to the hypothesis that the greatest effect of malnutrition on ultimate size and performance of the mature individual is produced during the period of maximum growth. There is a great possibility that children severely malnourished during the first six months of life may retain a permanent mental deficiency. It is therefore important that nutrition programs in compensatory programs include nutrition education for the parents, and perhaps supplemental feeding programs for children too young to be enrolled in the educational component of the program.

Research by Chase and Martin (1970) has indicated that both the time when malnutrition begins and the duration of malnutrition are critical issues. They evaluated the psychomotor development of 19 children some 3 1/2 years after they had been hospitalized for "generalized malnutrition" during the first year of life. These children were compared with 19 controls who were adequately nourished all their lives. The psychomotor development of children hospitalized before four months of age did not differ significantly from the controls in the study. However, those malnourished children hospitalized after four months of age, who presumably suffered longer from malnutrition, performed at a significantly lower level than either the control children or the

malnourished children hospitalized prior to four months of age. These significant performance decrements were found in five areas: gross motor development, fine motor development, adaptive behavior, personal-social development, and above all, language development.

Naeye (1970) suggests that the age at which malnutrition occurs is important since the brain is more sensitive to nutritional deficiency at the time of the most rapid cell division. He found that diet therapy started before the age of four months was more effective than treatment begun between four and twelve months. In a review of the literature, Birch and Grotberg (1971) suggest that the effects of inadequate nutrition on growth and development depend to a large extent on the severity, timing (pre- and postnatal), and duration of the nutritional deprivation. Botha-Antoun et al. (1968) suggest that the greatest effects of undernutrition on mental and physical development may be produced at periods of maximal growth, and probably will not be reversed with later adequate nutrition. They studied children who had been malnourished between three and eighteen months, focusing on the later effects of malnutrition on intellectual performance and psychomotor activities. They found that the average IQ was lower for the malnourished children, and that the age of walking and talking were later. In a study of Guatemalan children, Cravioto, DeLicardie, and Birch (1966) found that intellectual development in malnourished young children was related to the age of the child at the time of affliction and to the duration of the malnutrition. Performance on psychological tests was related to nutritional factors, and not to

differences in personal hygiene, housing, cash income, or other social and economic variables.

Klein (1969) suggests that the central nervous system may be particularly susceptible to the effects of malnutrition during the last trimester of pregnancy and the first six months of life. The effects of malnutrition seem to vary inversely with the age of onset and directly with its duration and severity.

To summarize, research studies point up the importance of several factors concerning malnutrition. The earlier the child is malnourished (even beginning during the last trimester of pregnancy), the more severe the effects usually are. Severity of the malnutrition also dictates the child's intellectual development, since early, severe forms of malnutrition generally bring about more retardation, both physical and mental. Duration is an important consideration in the study of malnutrition, since the longer a child is malnourished, especially if the malnourishement begins at an early age, the more severe, and sometimes irreversible, are the effects. Type of malnutrition is also a consideration since marasmus, which strikes younger infants, generally causes more damage than kwashiorkor, which strikes older infants.

What Are the Effects of Malnutrition?

A study of the effects of malnutrition raises questions like these: Is the retardation permanent or reversible? What areas or abilities are affected? What are the contributions of environmental and sociocultural factors?

Frisch (1970) suggests that the difference in reversibility of the effects of malnutrition seems to be related to the age at which the child is affected. It appears that the greatest risk of irreversible brain damage occurs in children who suffer deprivation before birth or shortly thereafter. Winick (1969) suggests that a low protein diet stunts the brain as it stunts the rest of the body, and that damage done to the brain of a human infant may be irreversible if malnutrition occurs before six months of age. Eichenwald and Fry (1969) suggest that inadequate protein nutrition or synthesis, or both, during brain development results in changes in function, and that, if the degree of deprivation were sufficiently severe and prolonged, the change in function might be permanent.

Latham (1969) cites a study in which malnourished children who received nutritionally adequate diets, gained an average of 18 points on IQ tests, while the well-nourished children who were used as a control group showed no gain. He suggested that because of dietary deficiencies the malnourished children had not reached their full potential and that correction of deficiencies resulted in a rise in IQ, whereas the well-nourished control group children showed no changes over the same time period. Lederberg (1968) suggests that stunted physical growth due to malnutrition in childhood is beyond the reach of an adequate diet in later life, and that mounting research evidence indicates that the same may be true for mental development.

Cravioto and Gaona (1967) used Mexican elementary school children from a rural village in an effort to discover the relationship between

early malnutrition and auditory-visual integration. The tallest 25% and the shortest 25% of the children between the ages of 7 and 12 were tested for their ability to integrate auditory and visual stimuli. Short height was considered an indicator of early malnutrition. The 296 children were individually asked to identify visual dot patterns corresponding to rhythmic auditory patterns. Ability improved with age, with rapid improvement occurring between the ages of 9 and 11. At each age level, the average performance of the taller group was better than that of the shorter group. It was suggested that early malnutrition which produces integration difficulties may affect the child's ability to read, since reading requires the ability to make these transformations.

Osofsky (1969) reports a study in which malnourished infants were followed up eleven years later. He suggests that malnutrition affects intellectual development, and is apparently irreversible in the age group studied. Eleven years later the children had difficulty in visual-motor ability and pattern perception, and in many ways resembled brain damaged children.

Rajalakshmi (1968) points out that nutritional remediation alone is not sufficient to overcome the effects of malnutrition and mental retardation in children whose social and cultural environments are totally lacking in emotional and psychological stimulation. Encouraging parent participation through the compensatory programs could

help overcome some of the environmental factors which often accompany poor nutrition. For example, the Home Start program, which emphasizes the role of the mother in the education of the child, provides guidance to parents in teaching and intellectually stimulating their children. Adding nutrition education would provide a two-pronged attack on the problem.

Rendon et al. (1969) reports a study with eighteen malnourished hospitalized children and eighteen controls, which revealed that the malnourished children evidenced noticeable deficiencies in anthropometric measurements, development, and functioning levels. Deficiencies in all areas of infant mental development and especially in the development of language and social-personal attitude persisted even after nutritional recovery was satisfactory. Rendon suggests that the deficiencies of the malnourished group cannot be attributed solely to reduced protein and calorie intake because of multiple interrelated factors, such as lack of environmental stimulation, extreme poverty, poor parent education, and parent intelligence. Sandstead et al (1971) suggest that other compounding factors include a marginal family income, a lack of parental understanding of nutrition, and a lack of parental supervision, particularly at mealtime. Scrimshaw (1968) suggests that psychological and social deprivation is also common among malnourished children, and can exert a direct influence on intellectual performance. He suggests that malnutrition can interact with heredity, infection, social and environmental factors to bring about physical and mental impairment.

It thus appears that if malnutrition occurs during early infancy, the damage is probably irreversible. It also appears that virtually all areas of human functioning are affected by malnutrition and the accompanying social and environmental variables.

Considerations in Nutrition Research

Klein and Yarbrough (undated) suggest caution in generalizing findings of any particular nutrition study to an extremely different population. Confounding variables in studying the effects of malnutrition include social class and child rearing practices, hospitalization, and medical factors such as intra-uterine infection and perinatal anoxia.

It thus appears that there are many difficulties in evaluating the effects of nutrition on cognitive development, since mental and social development are multi-determined traits. Malnutrition is one of many adverse environmental effects impinging on the child; others include mother's health and nutritional status, birth injury, pre- and postnatal infections, and complex social and psychological deprivations.

In setting up a study, the researcher must find an adequate control group so he can make meaningful comparisons. In selecting a population the younger the child, the better. The effects of malnutrition seem to vary inversely with the age of onset of malnutrition and directly with its duration and severity (Klein, 1969). Children should probably be studied from birth on, since they may suffer from other injuries, especially in an impoverished environment.

Selection of tests should be on theoretical grounds which reflect both the researcher's framework for conceptualizing the effects of malnutrition, and his theoretical point of view on cognitive development.

Very often sensory-motor scales are used to assess mental development in infancy. However, in selecting this type of test, the researcher is making the assumption that the child's level of sensory-motor development is a valid and reliable index of infant intelligence--an assumption which is generally unfounded.

Traditional IQ tests tell little about the relationship between malnutrition and mental development since most IQ tests are global measures, giving little information about problem-solving, response style, linguistic competence, perception, and memory. Ginsburg (1972) has an excellent discussion of this topic in his book, The Myth of the Deprived Child.

Studies of malnutrition have typically been conducted in underdeveloped countries. Generally these countries are culturally and linguistically different from the country in which the test was developed and normed. It thus appears that most existing measures of intellectual development are inappropriate for use in underdeveloped countries, unless they have been constructed for a particular country's population.

Social and cultural factors may confound research on the effects of malnutrition. Socioeconomic status differences are important considerations, since it has been shown that lower class mothers

svstematically treat children differently than middle class mothers do. Differences in intellectual development associated with dissimilar styles of child rearing can be detected early in infancy (Pollitt, 1969).

In designing research in the area of the effects of malnutrition on mental development, one must remember to consider the entire individual, including his complex inner functionings and his societal relationships, in trying to determine the role malnutrition plays in his life. Klein (1969) suggests there are six factors to be considered in designing studies: 1) an adequate control group; 2) supplemental feeding, so that both the experimental and control groups will be adequately nourished at the time of the study; 3) careful institution of the feeding program so that social variables are not confounded; 4) very young children, preferably newborns, as the population; 5) appropriate tests theoretically relevant and culturally appropriate; and 6) measurement of family characteristics.

There appear to be two types of study designs in the literature: retrospective and perspective studies. Retrospective studies define children who have been malnourished as compared to those who were not. They are able to use large numbers of subjects in a relatively short period of time, and contain a peer definition of the nutritional state during the critical period being examined. Controls must also be selected on the basis of nutritional history and may in themselves have been inadequately nourished. Perspective studies have fewer children, but the children are evaluated nutritionally by the researchers.

This evaluation offers better nutritional information and selection of controls at the time the study population is defined.

Recommendations for Future Research

Birch and Grotberg (1971) suggest that an adequate state of nutrition is necessary for good attention and for appropriate and sensitive responsiveness to the environment. It appears from the research that women who were malnourished as children are more likely to have disturbed pregnancies and children of low birth-weight, and increased risk of neuro-integrative abnormality. However, in cases where environmental, cultural, and social factors contribute much to the malnourished state, the emphasis in the programs should be an effort to improve the overall conditions of disadvantaged children.

Foster (1972) suggests that food programs are important aspects of the day care programs. Concern about inadequate nutrition in the day care centers came about in part because of research indicating the relationship of intellectual development and infectious diseases to adequate nutrition. Breakfast, lunch, and nutritious snacks will help raise a child's resistance to disease and may also bring about motivational changes by increasing a child's responsiveness to stimuli. A food service program of a day care center can also provide a laboratory for learning about food, nutrition, and socialization.

Project Head Start has helped provide information about nutrition and nutritious food to thousands of children and their parents across the country. However, North (1968) suggests that these various

feeding and education programs now need to be evaluated.

Some of the problems associated with preschool malnutrition include the mother's lack of proper foods for optimal growth and development; the high cost of protein rich foods necessary for optimal early development, and lack of transportation of food and proper food processing or preservation. Some of the problems can be overcome through educational programs such as those associated with day care programs. However, broader federal programs will probably be necessary to overcome the food cost and transportation problems.

Future research should also include more longitudinal studies exploring the effects of malnutrition and mental development, taking into consideration the many factors discussed above.

Summary

Research indicates that good nutrition is of major importance in the physical development of the brain, and enables a child to benefit optimally from the environmental stimulation necessary for cognitive development. Most evidence suggests that malnutrition during the earliest months causes, or contributes to, retarded mental and physical development. If malnutrition occurs after the first year, subsequent adequate nutrition can often bring the child closer to his capabilities. Factors important in the study of malnutrition include age of onset, severity, duration, and type of malnutrition. Also of concern is whether the effects of malnutrition are reversible or permanent, just what areas or abilities are affected, and the contribution of the cultur

and of the environment.

Future research and concern should include more carefully controlled studies attempting to relate malnutrition and mental development. In addition, nutrition education programs in day care centers should be established to reach disadvantaged populations.

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*ERIC/ECE is responsible for research documents on the physiological, psychological, and cultural development of children from birth through age eight, with major focus on educational theory, research and practice related to the development of young children.